Tropospheric CO Differences Between Two Minimization Methods and Validations

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1. CO Profile Comparisons Between AIRS V5 and TES

- Data used are from Dec. 2005 to July 2009.
- All pixels are collocated TES and AIRS that are measured within 15min.
- Day and night time data are used.
- Only data with TES cloud optical depth less than 1 are used.
- Various sampling sizes are used (5x8km for TES, 45X45km for AIRS).

2. AIRS CO Retrievals Using Optimal Estimation and Comparisons with V5

- Motivation: intercompare sensors with similar algorithm to address the issue how the prior information is incorporated when the observed information contend is low.
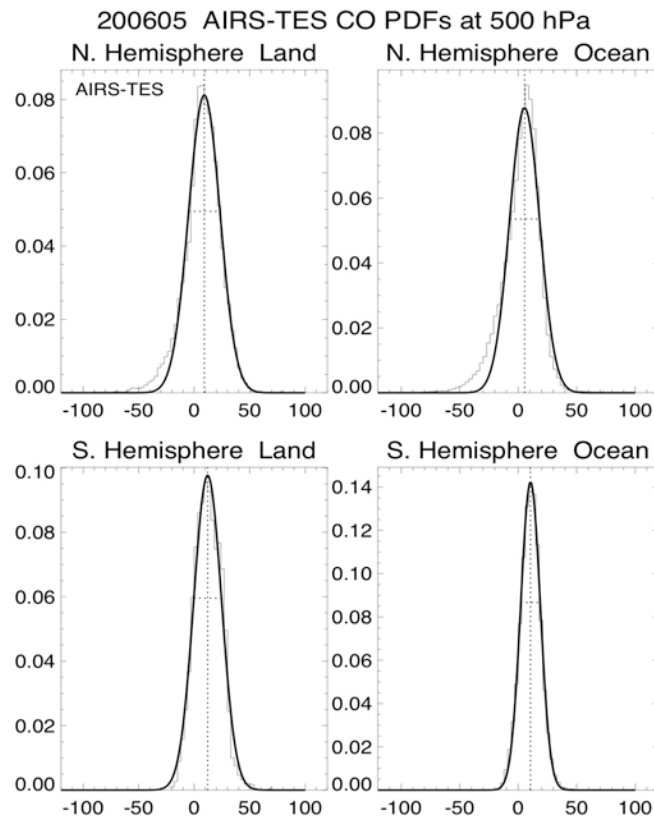- Equations:

$$y = f(x, b) + n_\varepsilon,$$

$$X_{n+1} = x_a + C_a K_n^T (K_n C_a K_n^T + C_\varepsilon)^{-1}[y - y_n - K_n(x_a - x_n)]$$

- MOPITT *a priori* fixed globally, mean profile is similar to V5 1st guess.
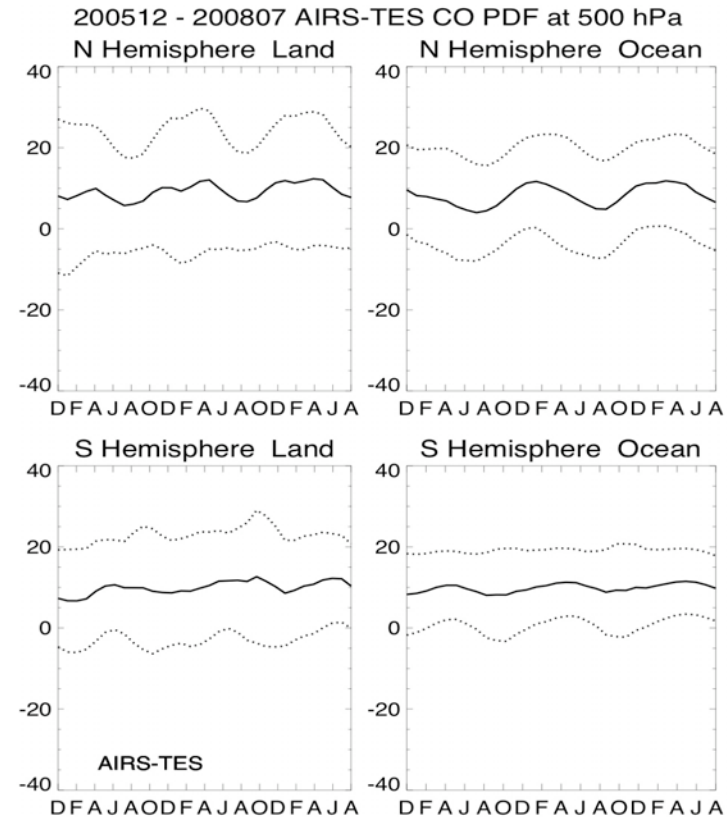- Developed by Warner & Wei based on AIRS V5 off-line codes.

AIRS - TES CO Normalized PDFs For March, 2006 at 500mb

AIRS & TES 500mb CO Biases and Variability For Dec. 2005 to July 2009

200605 AIRS-TES CO PDFs at 500 hPa


200512 - 200807 AIRS-TES CO PDF at 500 hPa

- Monthly Gaussian Functions are fitted from the PDF distributions of matching AIRS-TES at 500mb for NH and SH over land and ocean.
- Modes and FWHM from the Gaussian Functions are plotted from Dec. 2005 to July 2009.

AIRS - TES CO Normalized PDFs For March, 2006 at 800mb
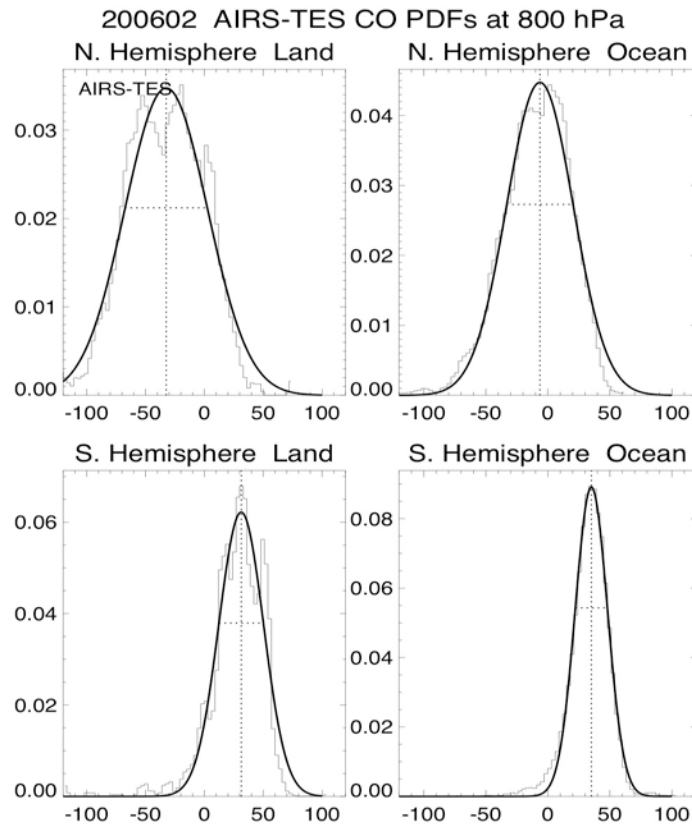
AIRS & TES 800mb CO Biases and Variability For Dec. 2005 to July 2009

200602 AIRS-TES CO PDFs at 800 hPa

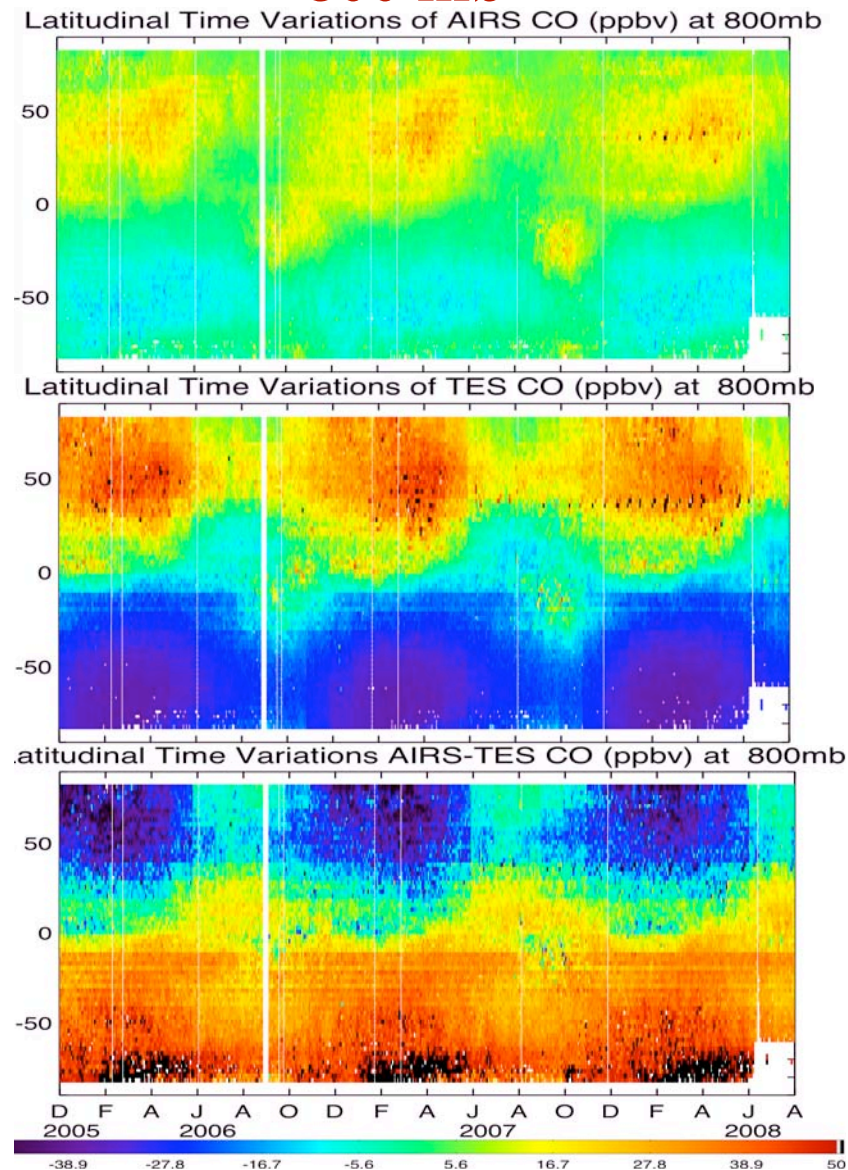200512 - 200807 AIRS-TES CO PDF at 800 hPa
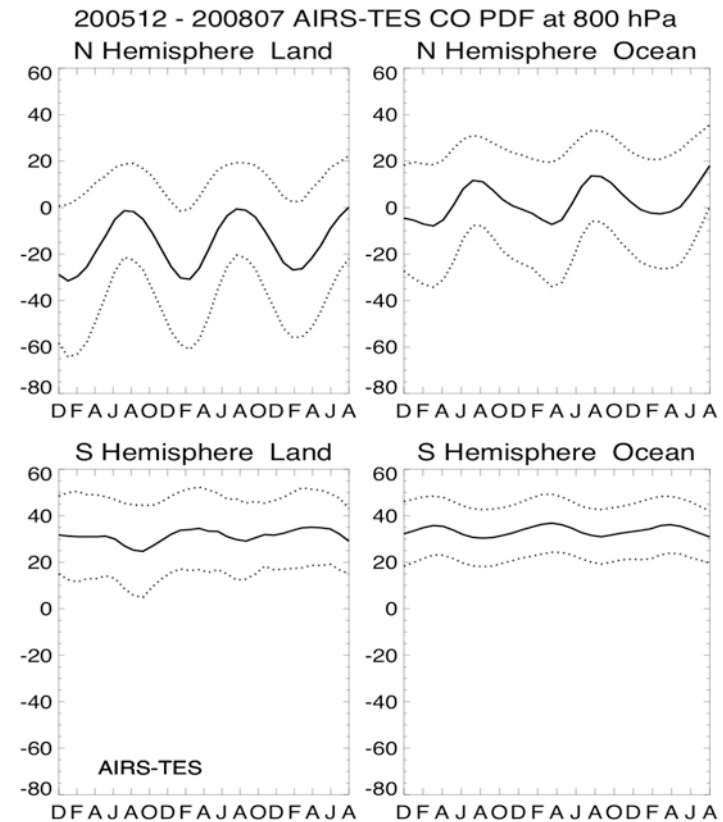
- AIRS and TES biases show higher daily and seasonal variability at 800mb indicating different product sensitivities at this level than at 500mb.
- Biases are significantly higher at 800mb in the SH with AIRS higher than TES.

CO VMR Latitude ~ Time 200512 - 200907
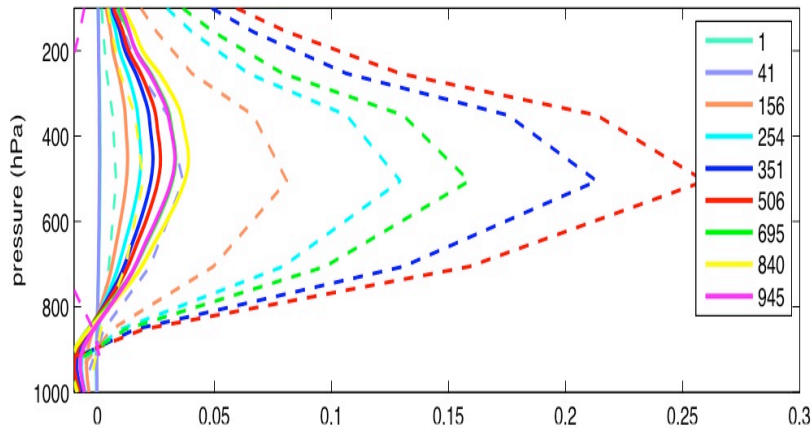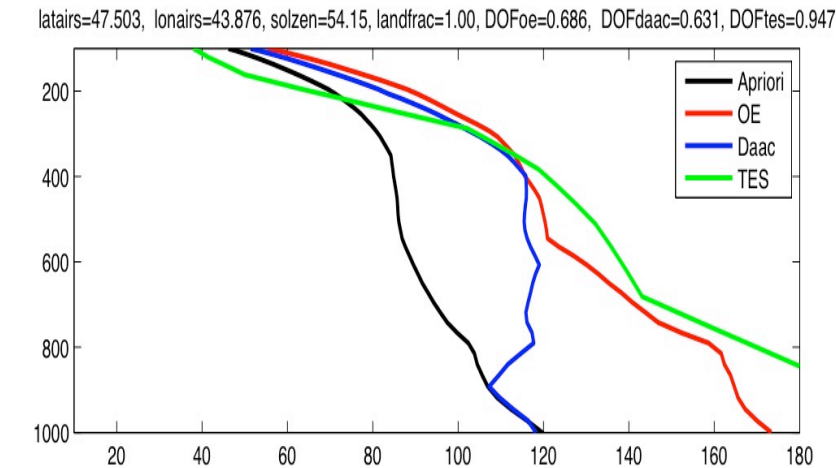
500 mb
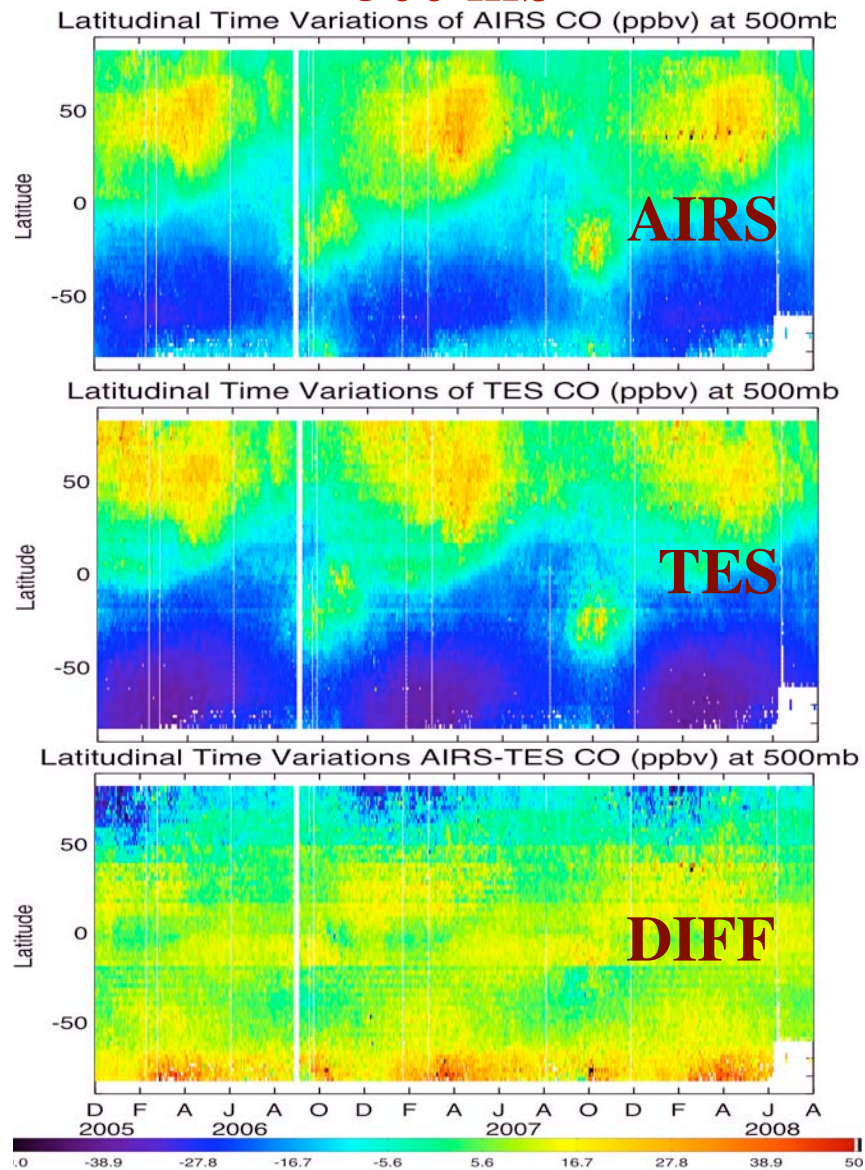
800 mb

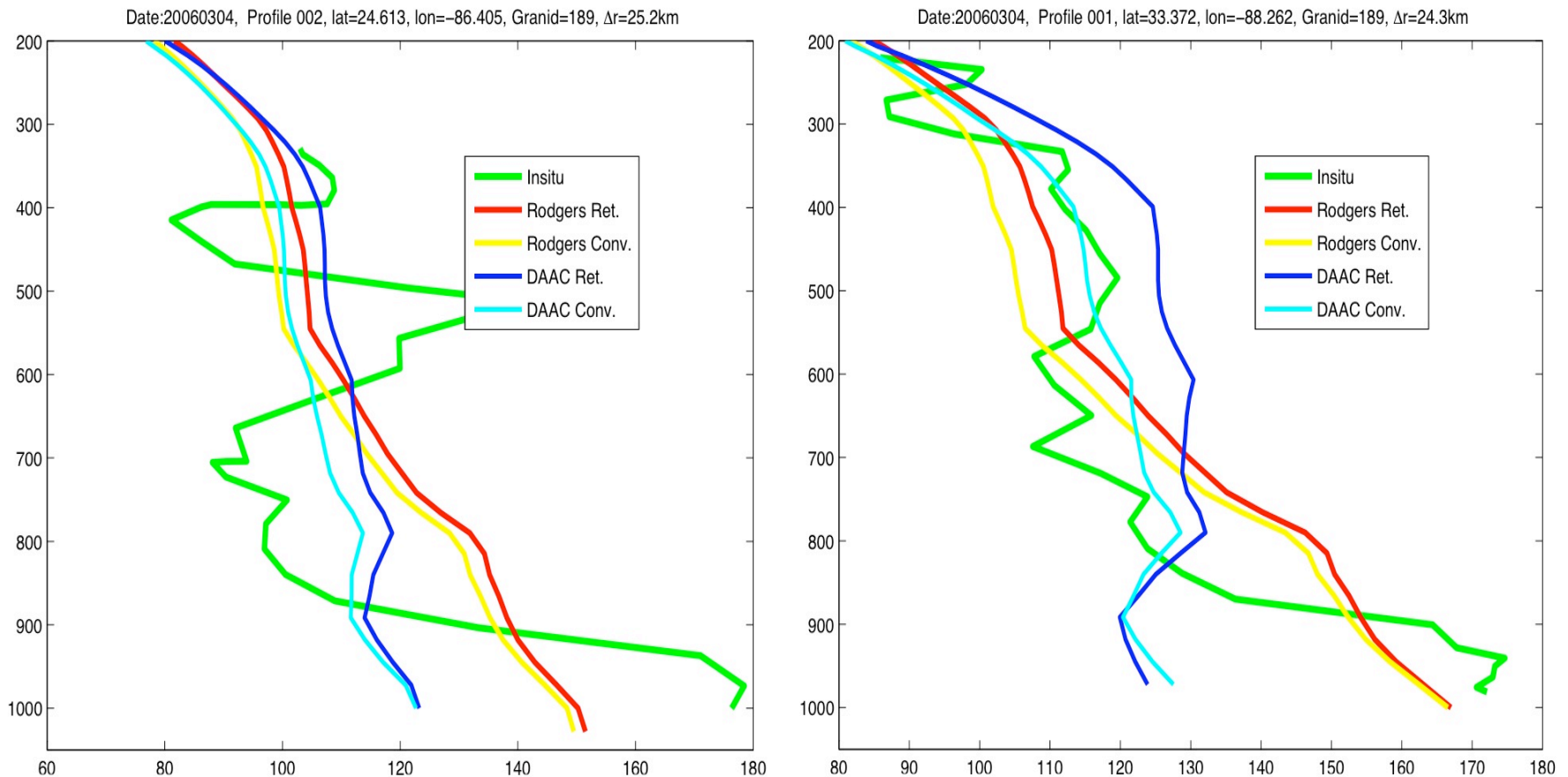Best: Source regions & High plumes;   Worst: polar regions & SH background

A typical NH profile over on 20060304 near the Southeast US agricultural fires

latairs=47.503, lonairs=43.876, solzen=54.15, landfrac=1.00, DOFoe=0.686, DOFdaac=0.631, DOFtes=0.947

- AIRS V5 CO converge towards the 1st guess in the lower troposphere.

- The *a priori* constrain leads to higher CO in the lower troposphere for both AIRS OE and TES CO.

- AIRS OE averaging kernels indicates most sensitivity at 500mb where AIRS V5 is accurate.

Typical NH profiles during INTEX-B Mar. 4, 06

Date:20060304, Profile 002, lat=24.613, lon=−86.405, Granid=189, Δr=25.2km

Date:20060304, Profile 001, lat=33.372, lon=−88.262, Granid=189, Δr=24.3km

Legend:
- Insitu
- Rodgers Ret.
- Rodgers Conv.
- DAAC Ret.
- DAAC Conv.

• CO profiles are very different between AIRS V5 and OE although convolved *in situ* profiles agree with the retrievals very well in both cases.
• To achieve lower troposphere accuracy, sometimes we sacrifice the mid-troposphere accuracy in regions with high CO concentration.
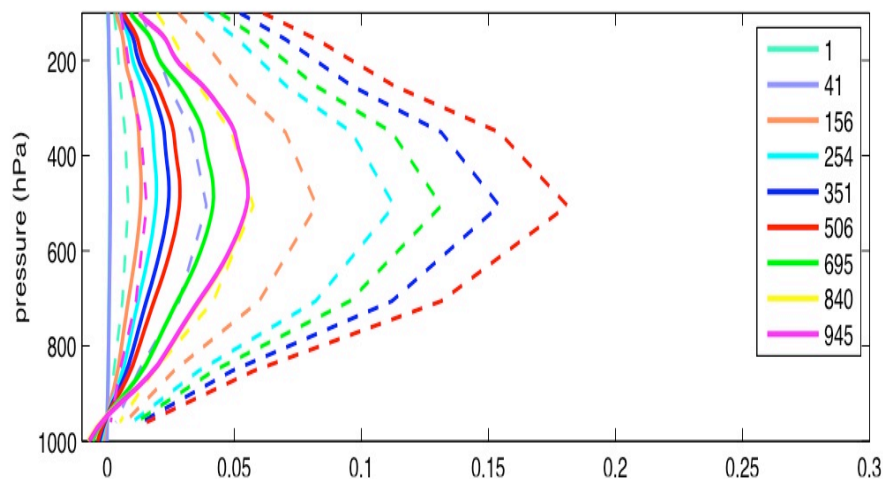
A typical SH CO profile over Ocean

latairs=–47.675, lonairs=68.557, solzen=47.72, landfrac=0.00, DOFoe=0.936, DOFdaac=0.544, DOFtes=1.005
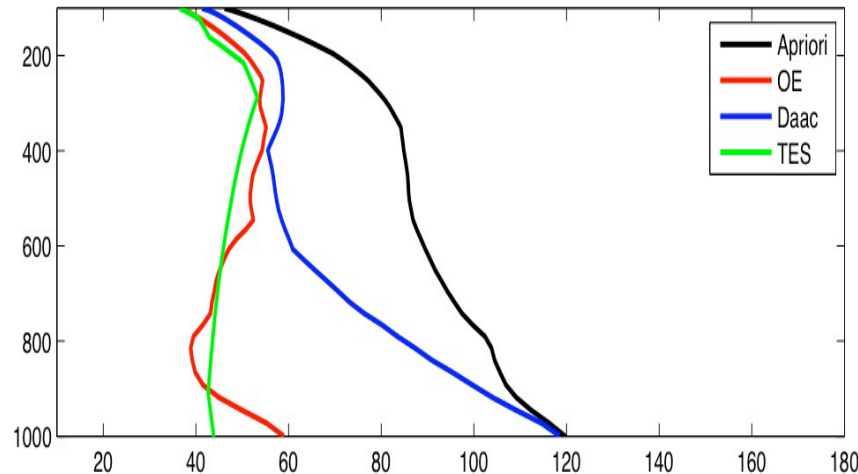
• AIRS V5 CO converge towards the 1st guess in the lower troposphere.

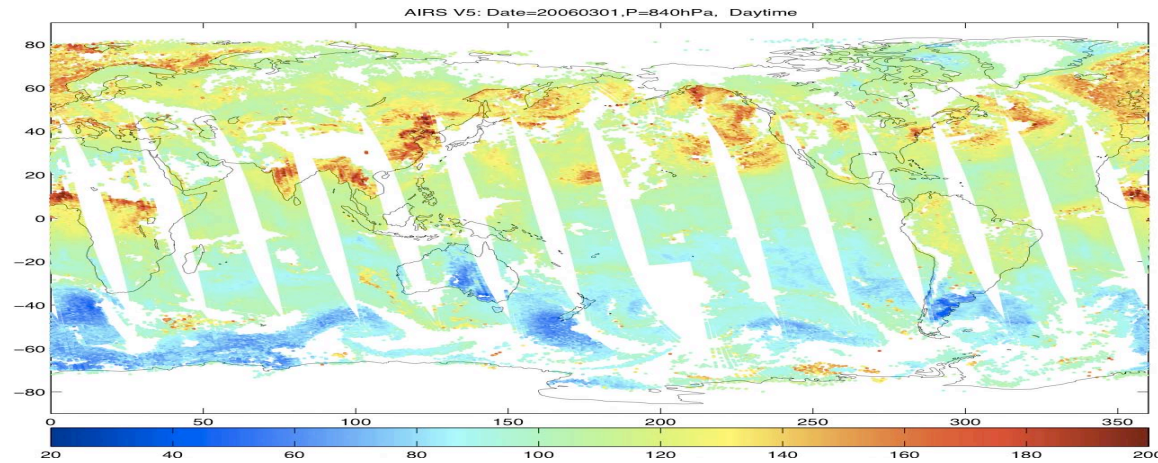• AIRS OE can capture very low CO in the clean region over SH oceans.

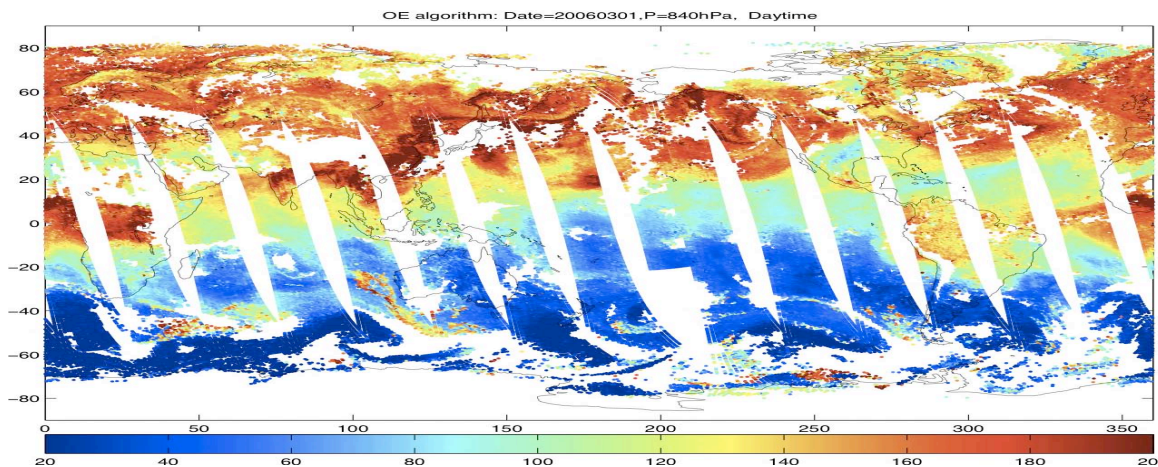• Agreements between AIRS CO using OE and TES CO agree very well over this region.
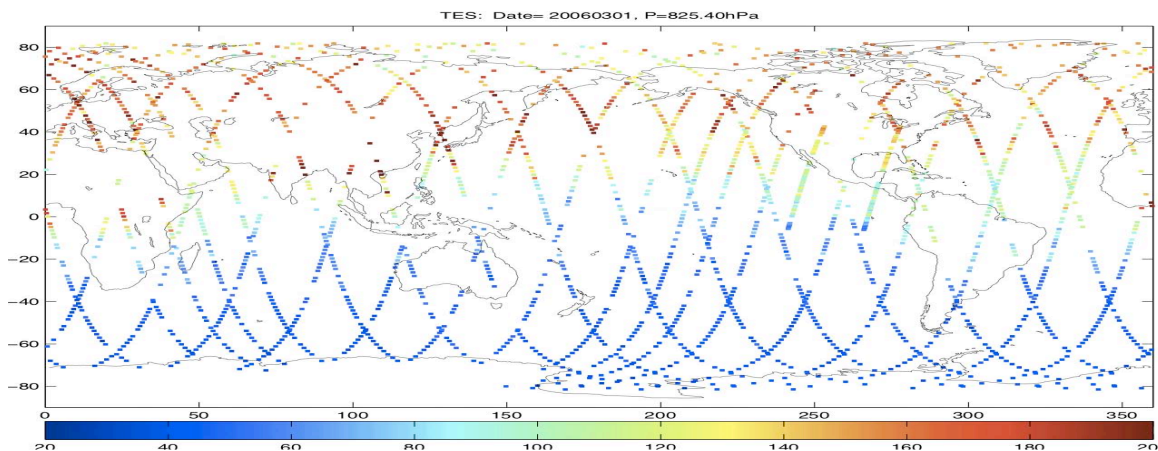
20060301
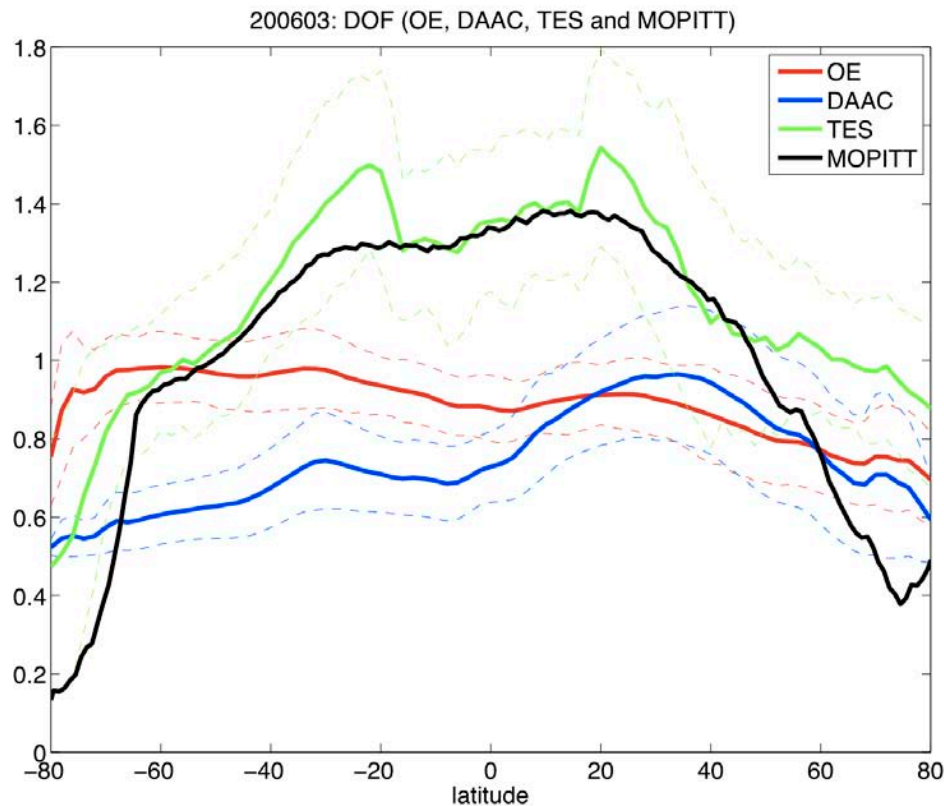
V5 840mb CO

OE 840mb CO

TES 825mb CO

DOF Analysis between two algorithms for March 2006

AIRS V5 CO (blue), AIRS OE CO (red), and TES CO (green)

200603: DOF (OE, DAAC, TES and MOPITT)

Legend:
- OE (red)
- DAAC (blue)
- TES (green)
- MOPITT (black)

- AIRS OE CO DOFs average between 0.8 to 1.

- AIRS V5 DOFs are higher in the mid-latitude NH.

- TES CO DOFs are higher than 1. at mid- and low-latitudes.

CO Differences are comparable at 500mb between AIRS_V5-TES and AIRS_OE-TES

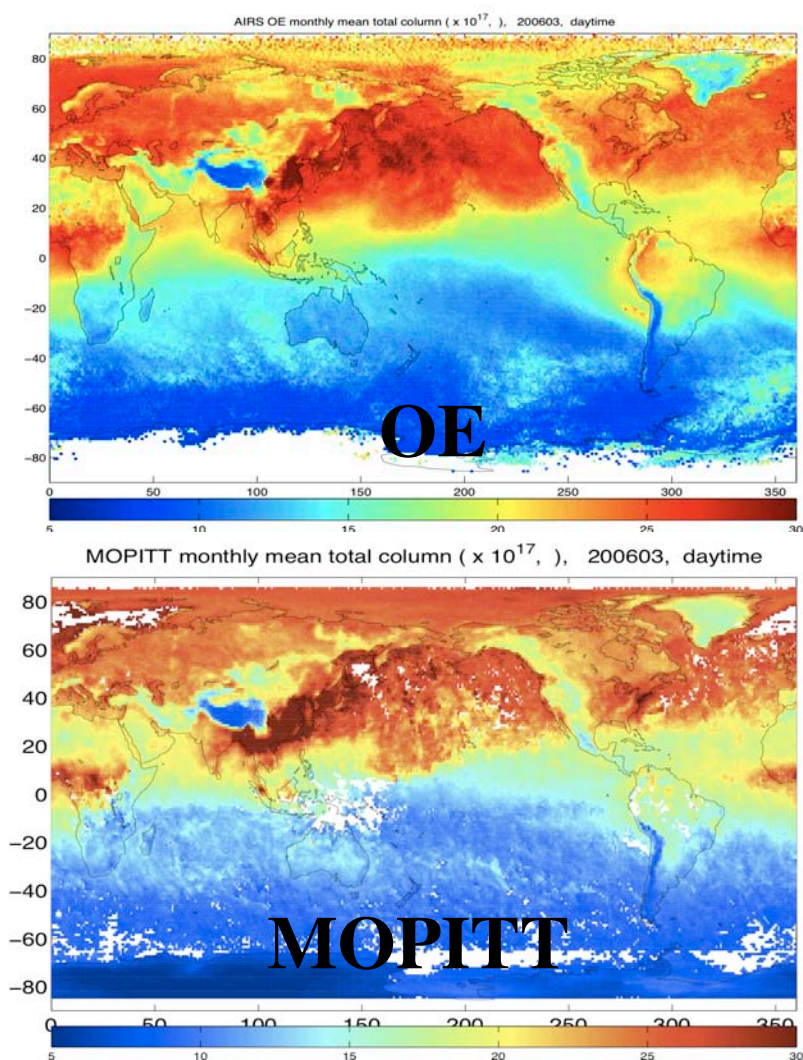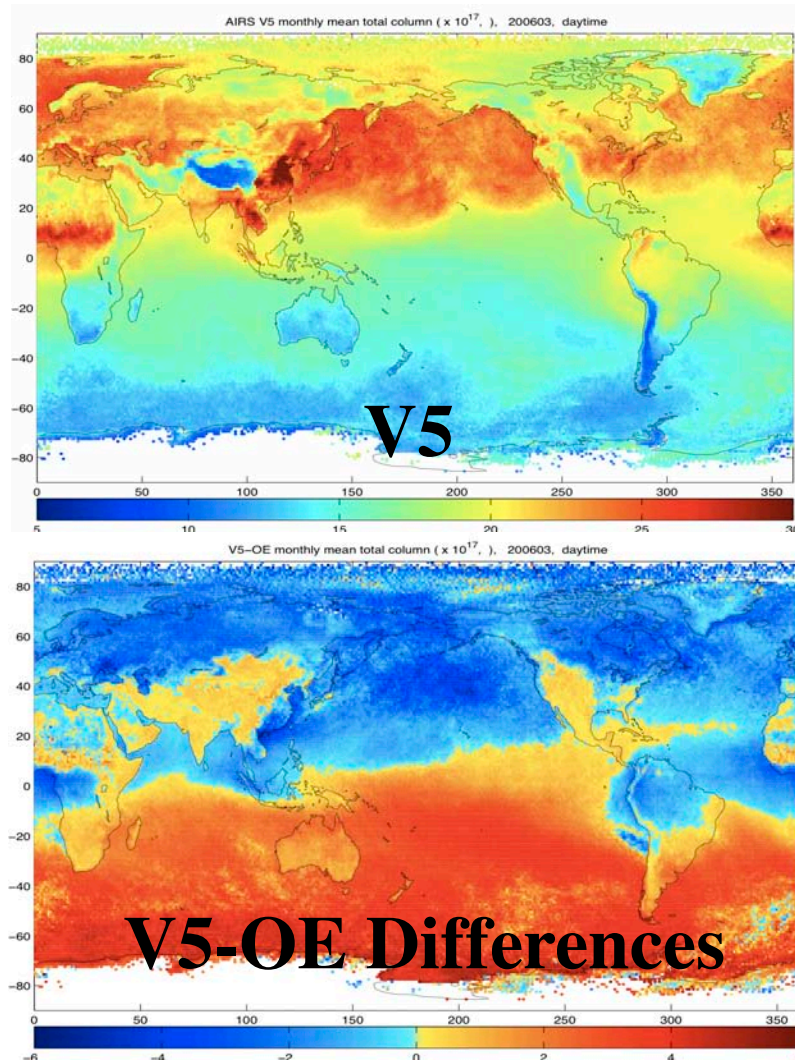200603 AIRS-TES CO PDFs at 500 hPa

20060331 AIRS-TES CO PDFs at 500 hPa
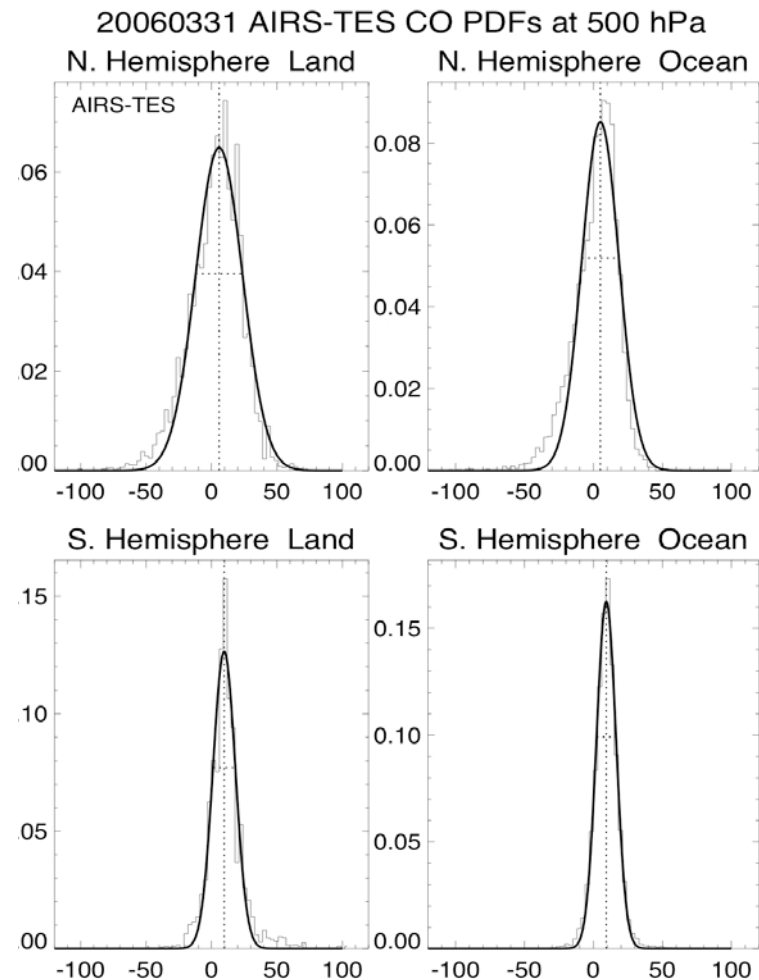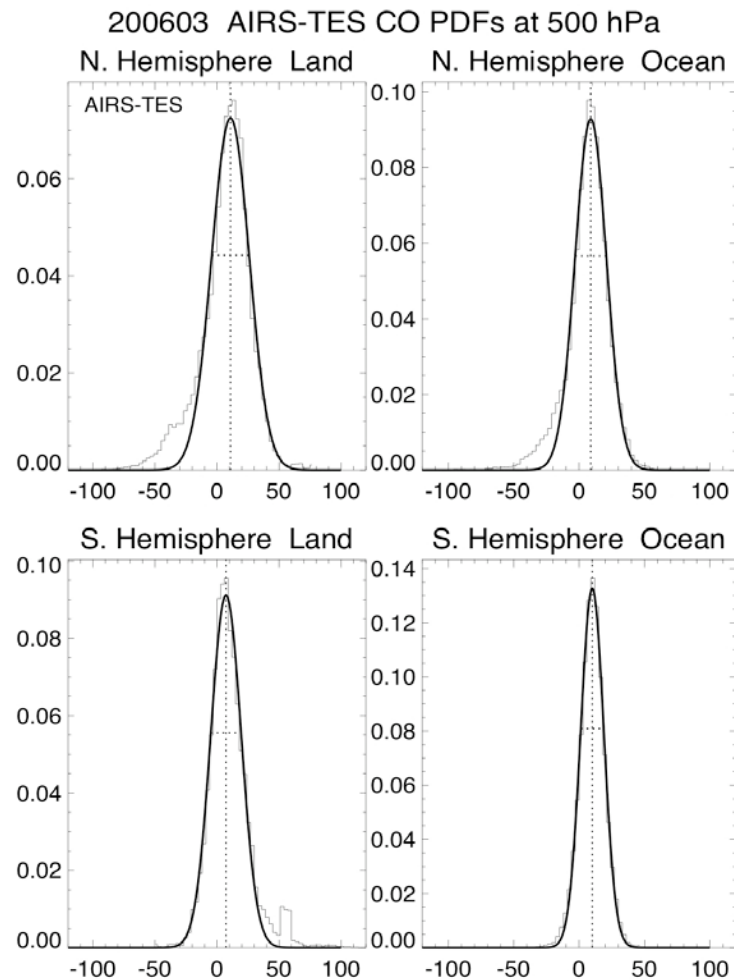
Biases are significantly reduced at 800mb by ~20 ppbv over NH land, and ~30 ppbv in the SH!!
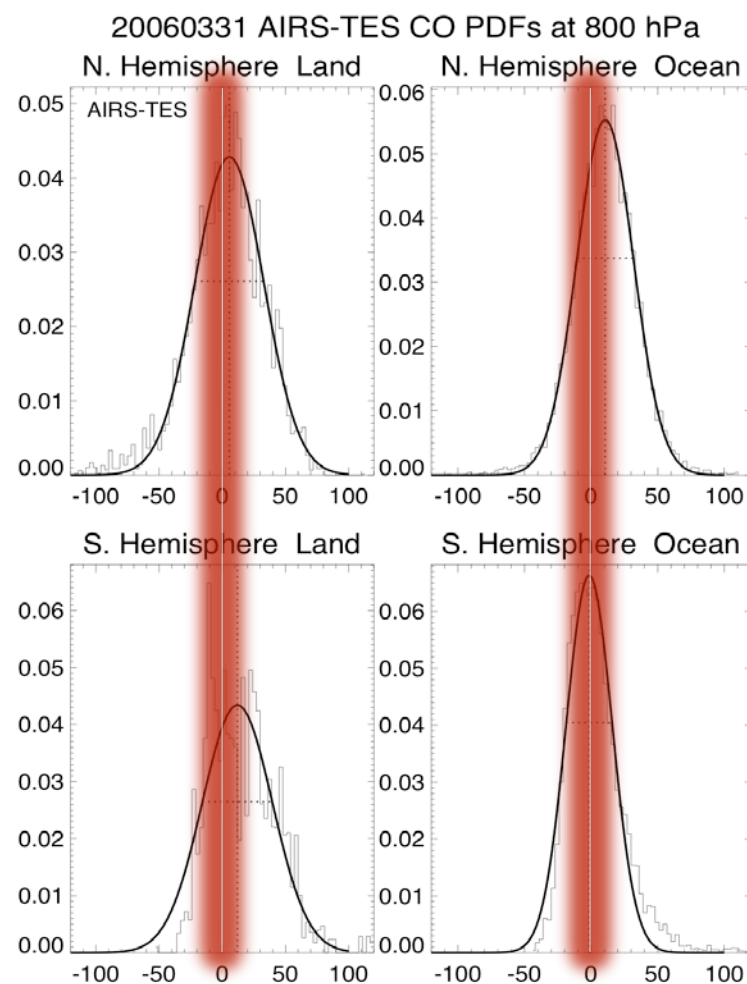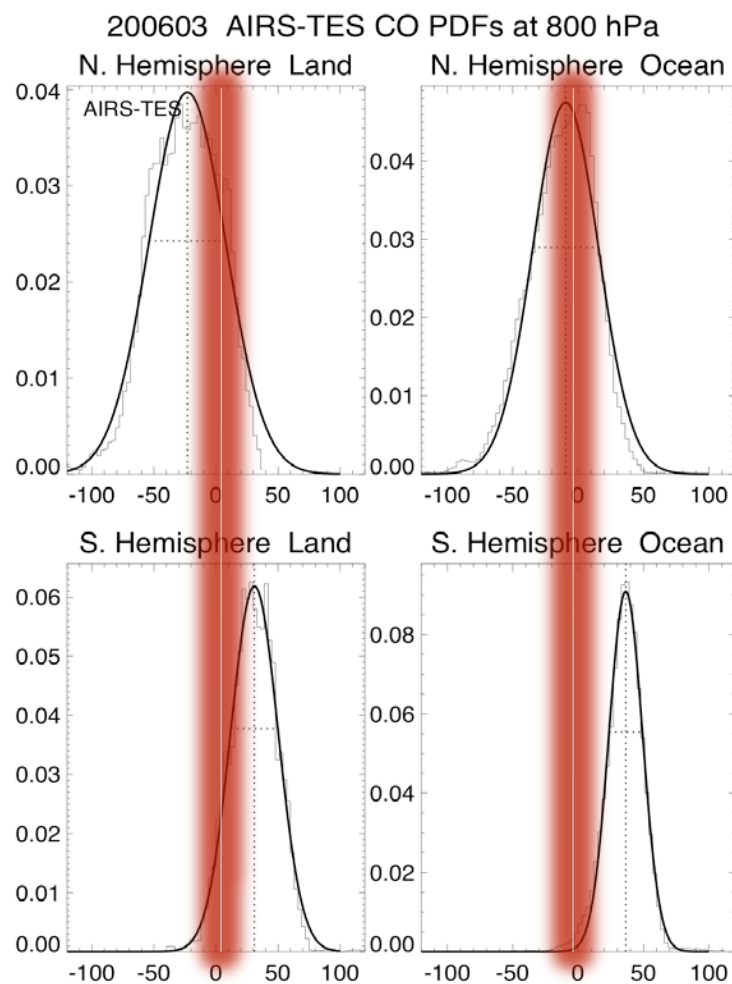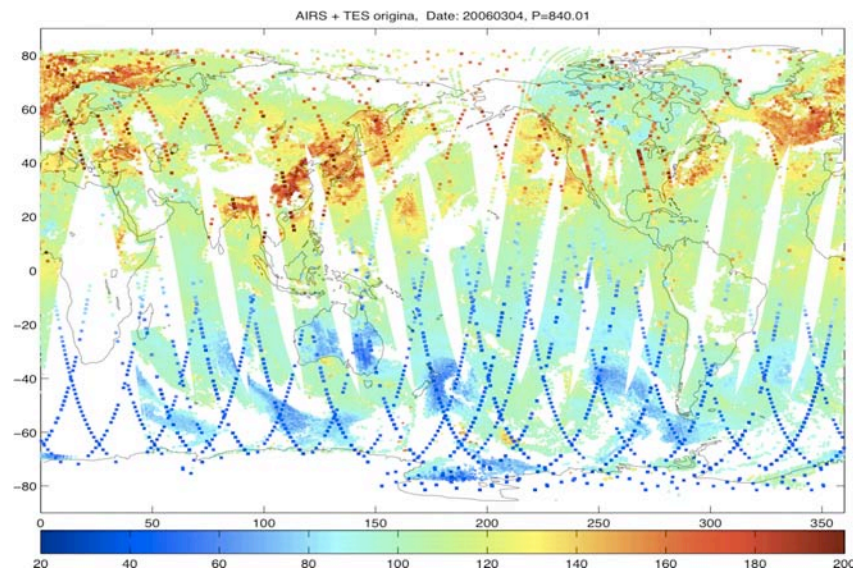
AIRS CO total column
Compared with MOPITT Mar., 2006

- OE CO total columns are higher in the NH and lower in the SH compared to V5 CO by 30%.
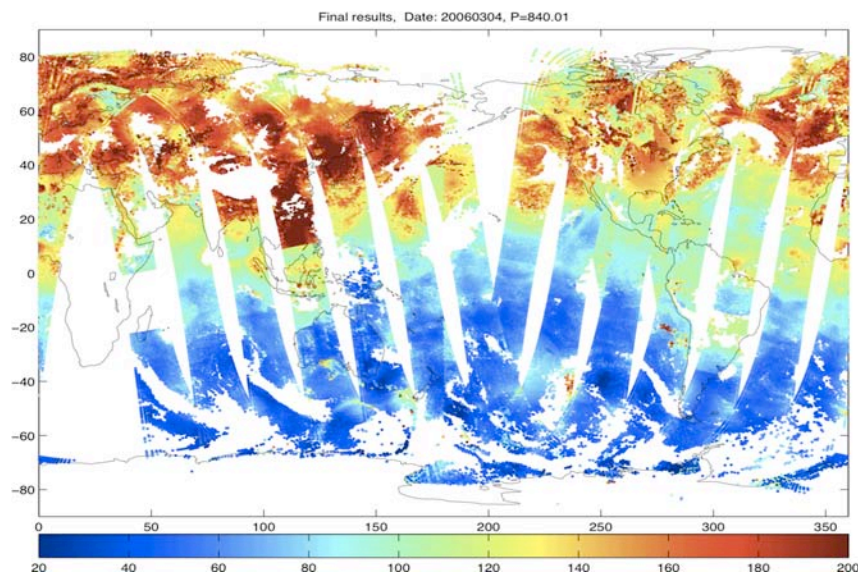- Better agreement with MOPITT with main differences at the Polar region.
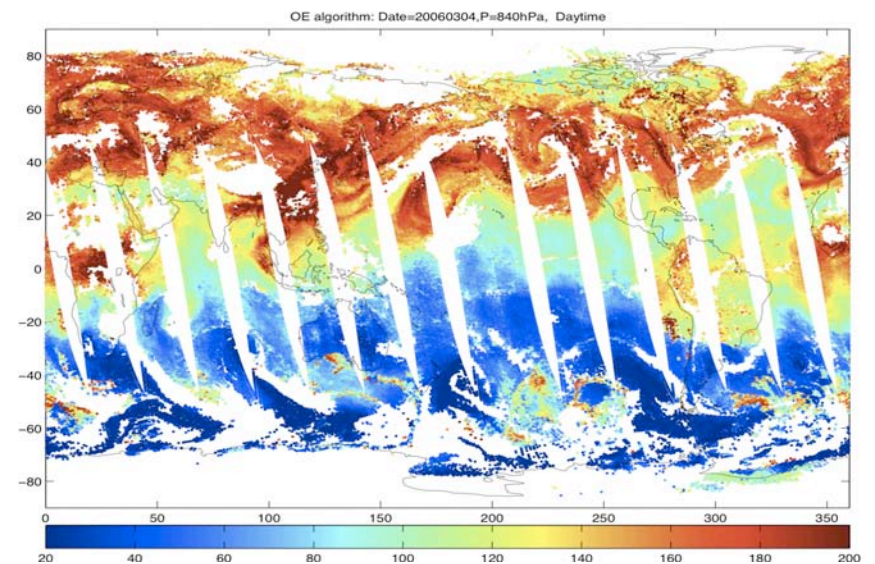
AIRS V5 and TES L2 CO at ~800mb

OE technique provides comparable CO structures in the lower troposphere than using fused AIRS and TES, but provide more consistent patterns.

AIRS w/ TES as 1st guess ~800mb

AIRS CO using OE ~800mb

Summary and Future Work

- Differences between AIRS and TES CO mostly attribute to algorithm differences rather than sensor characteristics.

- Accuracies of AIRS CO using OE improved in the lower troposphere and southern hemisphere based on (limited) validations.

- Thorough validations are ongoing.

- Complete CO data records for the available observation period.